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(54) Driving device for industrial vehicle

(57) The drive for a vehicle such as a reach fork lift truck which includes an electric motor (1), reduction gears and a driving wheel (4) comprises a planetary gear (7) in the reduction gears including a sun gear (8), a ring gear (25), a plurality of pinion gears (26) and a pinion cage (10) connecting these pinion gears (26), thereby enabling the driving arrangement to be low in height, compact and simplified and enabling a steering wheel to be arranged at a location which facilitates its operation.

FIG.4

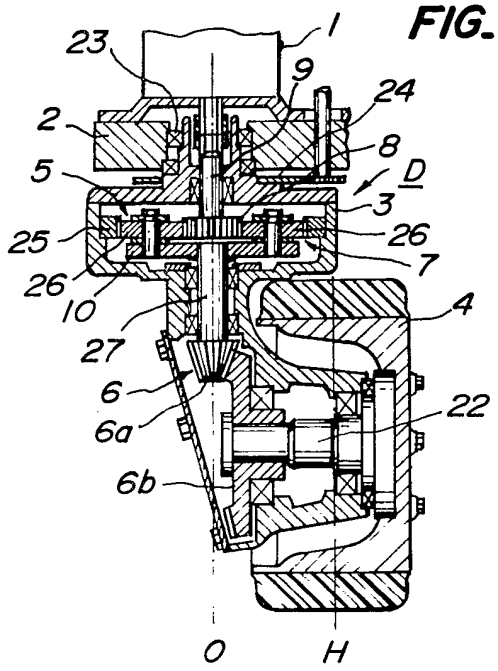


FIG.1
PRIOR ART

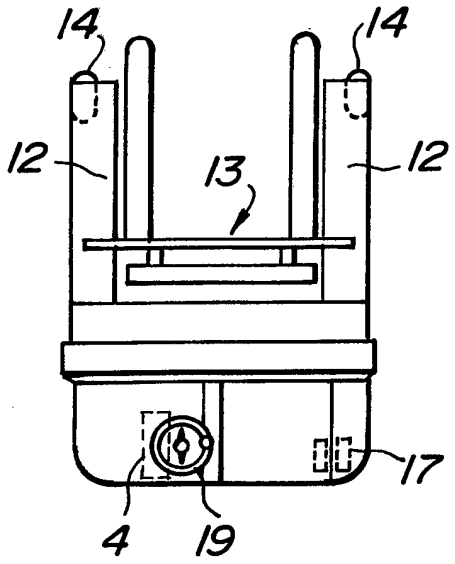


FIG.2
PRIOR ART

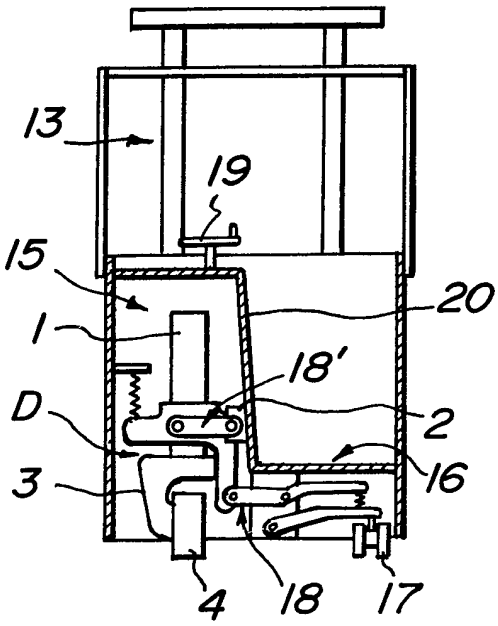


FIG.3
PRIOR ART

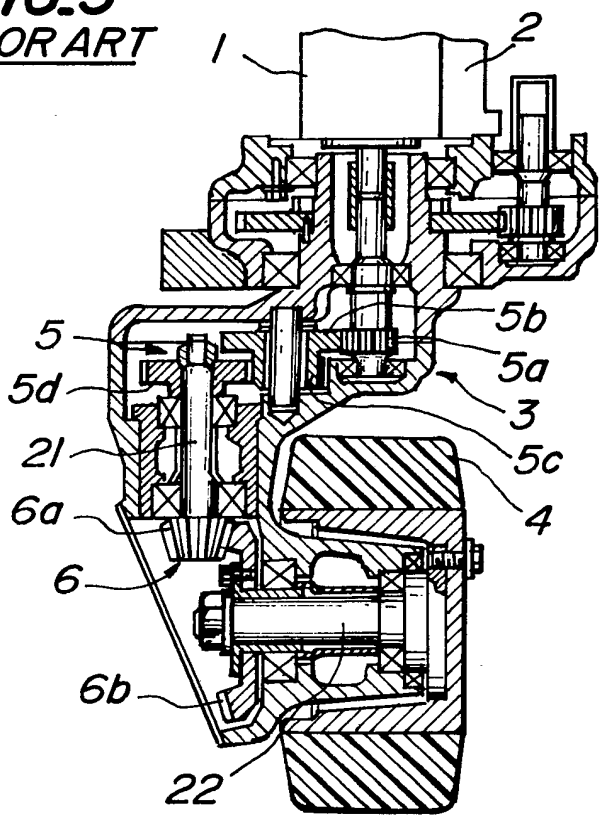


FIG.4

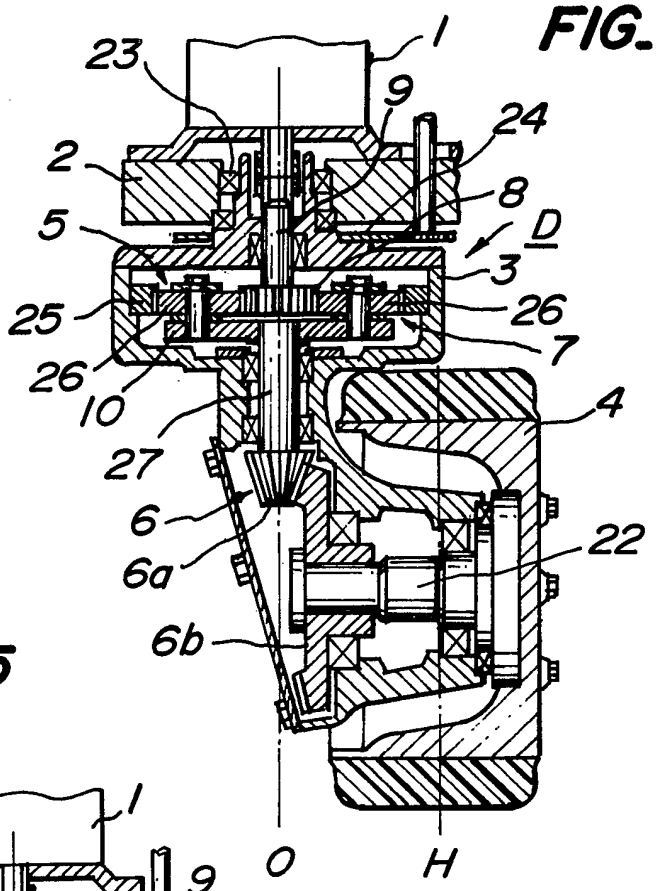
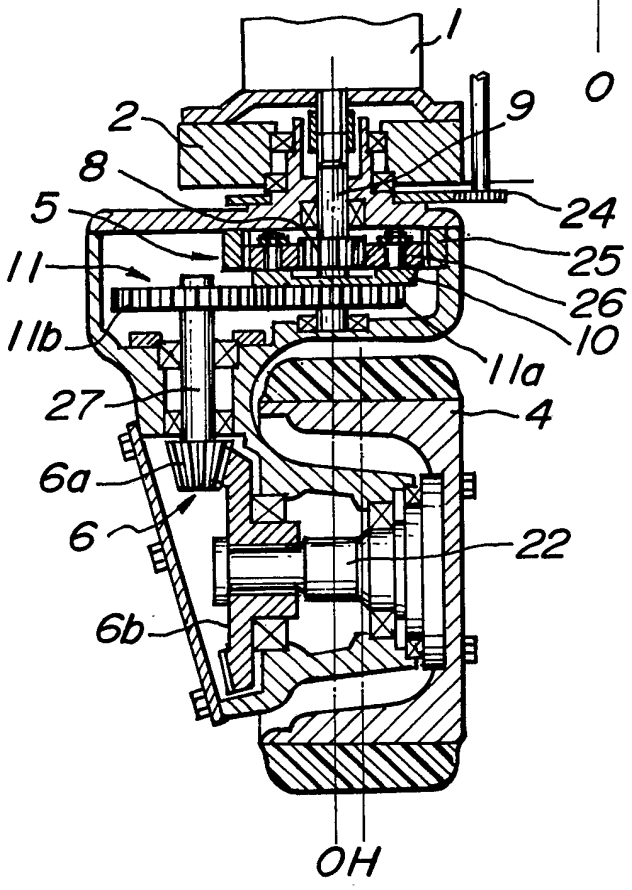

1
23
9
24
2
8
D
5
3
25
26
7
26
10
27
4
6
6a
22
6b
O
H

FIG.5


1
2
9
8
24
5
25
11
26
10
11b
11a
27
4
6a
6
22
6b
OH

SPECIFICATION

Driving device for industrial vehicle

This invention relates to a driving device for a reach type industrial vehicle such as a reach fork lift truck, whose driving and steering are performed by the same wheels.

The term "reach type" used herein means a type of vehicle having a loading attachment forwardly and backwardly movable such as a reach fork of a reach fork lift truck.

With an industrial vehicle of this type, as shown in Figs. 1 and 2, on a front portion of a vehicle body are arranged a pair of reach legs 12 which are provided with a loading attachment 13 such as a fork or the like slidable in a longitudinal direction of the legs and are provided at their front ends with front wheels 14. A rear portion of the vehicle body is formed on the left part with a power chamber 15 accommodating a driving arrangement D including an electric motor 1, a carrier 3 and a driving wheel 4 and on the right part with a cab 16 below which is arranged a rear wheel 17 in the form of a caster connected by a link mechanism 18 to the carrier 3 to transmit an appropriate load to the rear wheel 17 in response to vertical movement of the driving wheel 4. A steering wheel 19 is arranged above the power chamber 15.

Referring to Fig. 3, the driving arrangement D comprises the electric motor 1 mounted through a linkage 18′ on a support frame 2 fixed to a partition 20 dividing the power chamber 15 and cab 16, the carrier 3 being pivotally movable below the support frame 2, the driving wheel 4 rotatably secured to the lower part of the carrier 3, and reduction gears 5 and driving gears 6 arranged within the carrier 3 for transmitting the power of the electric motor 1 to the driving wheel 4. The reduction gears 5 are composed of four gears 5*a*, 5*b*, 5*c* and 5*d* for a two stage reduction and the driving gears 6 include bevel gears 6*a* and 6*b*.

With such an industrial vehicle, in order to minimize the size of the electric motor so as not to be bulky in the power chamber so long as the travelling performance of the vehicle is retained, the rotating speed of the electric motor 1 is increased to ensure sufficient driving power. For this purpose, it is required to increase the reduction ratio of the gears 5 as a two stage reduction above described or a three stage reduction as the case may be. In addition, a pinion shaft 21 extends downwardly from the gear 5*d* and is provided at its lower end with the bevel ger 6*a* rotatively driving the bevel gear 6*b* having a large diameter fixed to an axle 22 for the driving wheel 4 in the lower part of the carrier 3, so that the height of the driving arrangement D is high and hence the steering wheel 19 mounted on the upper portion of the carrier 3 covering the driving arrangement D occupies a high position, with the result that an operator must be in a higher position in the cab 16 to operate the steering wheel 19 which is disadvantageous.

To avoid this, the widths of the gears 5*a*, 5*b*, 5*c* and 5*d* could be narrowed to reduce the overall height of the reduction gears 5 and hence the driving arrangement D. With the industrial vehicle, however, the torque transmitted from the electric motor 1 to the driving wheel 4 is too large to permit gears 5*a*, 5*b*, 5*c* and 5*d* having narrow widths to be employed.

It is a principal object of the invention to provide a driving arrangement for a reach type industrial vehicle which eliminates the disadvantages of the prior art and for this purpose employs a planetary gear as reduction gears, which obtains a one stage reduction of gears and enables the gears to be formed in narrow widths, thereby reducing the height of the driving device so as to obtain the compact and simplified driving arrangement and making it possible to arrange a steering wheel at a location to facilitate its operation.

In order that the invention may be more clearly understood, preferred embodiments will be described, by way of example, with reference to the accompanying drawings.

Figure 1 is a plan view of a reach fork lift truck of the prior art as mentioned above;

Figure 2 is a partly sectional rear view of the truck shown in Fig. 1;

Figure 3 is a sectional view of a driving arrangement of the prior art as mentioned above;

Figure 4 is a sectional view of a driving arrangement of a first embodiment of the invention; and

Figure 5 is a sectional view of a driving arrangement of a second embodiment of the invention.

Referring to Fig. 4 illustrating a first embodiment of the invention, a driving arrangement D comprises a carrier 3 rotatably supported by a bearing 23 under a support frame 2 and adapted to be rotated by a steering gear 24 provided between the carrier 3 and support frame 2 by operation of a steering wheel (not shown). The carrier 3 is provided at its lower end with a driving wheel 4 and accommodates therein reduction gears 5 directly connected to an electric motor 1 and driving gears 6, through which the power is transmitted from the electric motor 1 to the driving wheel 4.

The reduction gears 5 are composed of a planetary gear 7 comprising a sun gear 8 connected to a driving shaft 9 of the electric motor 1, a ring gear 25 fixed to the carrier 3 and a suitable number (more than two) of pinion gears 26 between the sun gear 8 and

ring gear 25. These pinion gears 26 are connected by a pinion cage 10, to the rotating center of which is connected an upper end of a drive pinion shaft 27 integrally formed with the small bevel gear 6*a* of the driving gears 6.

According to the driving D of the first embodiment, the rotative driving force transmitted from the driving shaft 9 of the electric motor 1 to the sun gear 8 of the planetary gear 7 causes the pinion gears 26 to rotate about their respective axes and simultaneously revolve around the sun gear 8. The revolution of the pinion gears 26 around the sun gear 8 results in a rotation of the pinion cage 10 connecting the pinion gears 26 to rotate a small bevel gear 6*a* provided at the lower end of the drive pinion shaft 27 whose upper end is connected to the rotating center of the pinion cage 10. The rotation of the bevel gear 6*a* rotates the bevel gear 6*b* causing the driving wheel 4 to rotate through an axle 22 connected to the rotating center of the bevel gear 6*b*

Referring to Fig. 5 illustrating a second embodiment of the invention, different from the first embodiment, a pinion cage 10 is integrally formed with an idler drive gear 11*a* of idler gears 11, which is in mesh with an idler driven gear 11*b* of the idler gears 11, to the rotating center of which is connected the upper end of a drive pinion shaft 27. With this arrangement, the axis of the drive pinion shaft 27 is offset a distance between the axes of the idler gears 11*a* and 11*b* from the axis 0 of the driving shaft 9 of an electric motor 1 to bring the center H of a driving wheel 4 close to the axis 0 of the driving shaft 9, so that the rotating torque caused by the carrier 3 about the driving shaft 9 of the electric motor 1 is balanced with the rotating torque about the axis 0 derived from a traction force of the driving wheel 4, whereby improving a straightaway performance when straight travelling.

In the embodiments above described, as the reduction gears 5, a planetary gear 7 is employed whose reduction ratio is determined by dividing the sum of the numbers of teeth of the sun gear 8 and ring gear 25 by the number of teeth of the sun gear 8. Accordingly, the number of teeth of the ring gear 25 can be remarkably increased relatively to that of the sun gear 8 to obtain a large reduction ratio. Moreover, as the pinion gears which are more than two are interposed between the sun gear 8 and ring gear 25, the high rotating torque derived from the sun gear 8 is divided and transmitted to the respective pinion gears 26 from which the divided torques are transmitted by the pinion cage 10 connecting these pinion gears 26 directly or through the idler gears 11 to the drive pinion shaft 27, so that the widths of the sun gear 8, pinion gears 26 and ring gear 25 consitituting the planetary gear 7 can be theoretically reduced to less than one half the widths of reduction gears hitherto used.

In other words, the rotating torque at the sun gear 8 is divided by the number of the pinion gears 26 into smaller rotating torques which are transmitted to the pinion gears 26 and these rotating torques are together transmitted to the drive pinion shaft 27 connected to the pinion cage 10 as the sum of the rotating torques at the pinion gears 26 which is equivalent to the rotating torque at the sun gear 8. In addition, the planetary gear 7 in the above embodiments makes it possible to increase the reduction ratio sufficiently to employ a one stage reduction in the gear train corresponding to the reduction gears 5. In the first embodiment, therefore, the widths of the reduction gears are about less than one fourth of those of reduction gears in the prior art and in the second embodiment using the idler gears 11, the widths are less than three fourths of those of reduction gears in the prior art. Accordingly, the carrier 3 can be reduced in height and therefore the reduction gears 5 can be made remarkably compact in comparison with those including a three stage reduction when a large reduction ratio is required.

As can be seen from the above description, the driving device according to the invention employs a planetary gear as reduction gears which makes it possible to reduce the height of the reduction gears and hence of a carrier so as to reduce the height of a power chamber accommodating a driving arrangement of a reach type industrial vehicle, thereby lowering the position of a steering wheel arranged on an upper portion of the power chamber to facilitate the operation of the steering wheel and obtaining a compact and simplified driving arrangement which is inexpensive to manufacture.

CLAIMS

1. A driving arrangement for an industrial vehicle such as a reach fork lift truck including a carrier rotatably provided under a support frame carrying thereon an electric motor, a driving wheel rotatably provided at a lower portion of said carrier, and reduction gears and drive gears arranged within said carrier through which power from said electric motor is transmitted to said driving wheel, said reduction gears comprising a planetary gear consisting of a sun gear, a ring gear, a plurality of pinion gears and a pinion cage connecting the pinion gears.

2. A driving arrangement as set forth in claim 1, wherein said sun gear of the planetary gear is connected to a driving shaft of said electric motor and said pinion cage is connected to said drive gears.

3. A driving arrangement as set forth in claim 1, wherein said pinion cage of said planetary gear is integrally formed with an

idler drive gear and said drive gears integrally comprise an idler driven gear in mesh with said idler drive gear.

4. A driving arrangement substantially as described with reference to, and as illustrated in Fig. 4, or Fig. 5, of the accompanying drawings.

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